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12 February 1980

USSR Report

RESOURCES

(FOUO 3/80)

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ELECTRIC POWER AND POWER EQUIPMENT

SPECIFICATIONS FOR THE TK-450/500 STEAM TURBINES FOR NUCLEAR HEAT

Moscow ENERGOMASHINOSTROYENIYE in Russian No 9, 1979 pp 44-45

[Article: "A discussion of the engineering design of the TK-450/500 steam heat and power generating turbines for the power generating unit of a nuclear central heat and electric power station"]

[Text] The scientific and engineering council (NTS) of the Ministry of Power Engineering Machinery has considered the engineering desing for the TK-450/500 steam turbine for ATETs [Nuclear Central Heat and Electrical Power Stations] power units, designed in accordance with the technical specifications for the development and the resolutions of the NTS of the Ministry of Power Engineering Machinery and the USSR Ministry of Energy for the draft project plan of the TK-450/500-60 turbine.

The TK-450/500 turbine is intended for operation in a unit with the VVER-1000 (two turbines per unit) and the VVER-500 reactors, as well as the VK-500 reactor in a dual circuit configuration. In accordance with the decisions of the NTS of the USSR Ministry of Energy and the Ministry of Power Engineering Machinery for the draft project plan of the TK-450/500 turbine, the engineering design of this turbine was executed taking into account the possibilities of using it (with minimal reworking) for the following conditions: in a unit with vertical steam generators, having an economizer section and which provide a live steam pressure of 68 kgf/cm^2, the TK-450/500-68 turbine; in a unit with horizontal steam generators without the economizer section and which provide a live steam pressure of 60 kgf/cm^2, the TK-450/500-60 turbine.

The designs of the TK-450/500-68 and TK-450/500-60 turbines were executed with the maximum standardization both as regards the turbines themselves and as regards the complementary equipment and layout, and are distinguished only by the heights of the blaze of the first three stages of the TsVD [high pressure cylinder], and the presence of a high pressure preheater in the thermal circuit and layout of the TK-450/500-60 turbine.

The Main Technical Characteristics of the Turbines

	TK-450/500-68	TK-450/500-60
Live steam pressure, kgf/cm^2	68	60
Live steam temperature, °C	282.5	274.3
Steam moisture content, %	0.5	0.5
Intermediate superheating temperature, °C	260	260
Live steam flow rate, t/hr	3,000	3,157
Feedwater temperature, °C	198	221.2
Rotational speed, r.p.m.	3,000	3,000
Electrical power, MW:		
in the condensation mode	500	500
in the heat supply mode	450	450
Thermal load, GCal/hr	450	450
Specific heat consumption (gross) in the nominal condensation mode, KCal/KWH	2,672	2,689
Number of Cylinders, units	4	4
Number of stages:		
in the high pressure cylinder	2x6	2x6
in the medium pressure cylinder	2x6	2x6
in the low pressure cylinder 1	2x3	2x3
in the low pressure cylinder 2	2x4	2x4
The number of mains preheaters, units	4	4
Number of condensers, units	2	2
Weight of the turbine without the condensers, tons	1,400	1,400
Weight of the turbine with the condensers, tons	2,480	2,480

The turbine is designed as a single shaft, four cylinder type and consists of a TsVD [high pressure cylinder], a TsSD [medium pressure cylinder], TsND 1 [low pressure cylinder 1] and TsND 2. The flow-through sections of all the cylinders are dual flow types.

The high pressure cylinder has a baffle type steam header. The live steam is fed to the lower half of the high pressure cylinder via two steam lines through two blocks of stop and regulating valves. The steam is fed from the high pressure cylinder to a single stage separator--steam superheater (SPT) and then to the medium pressure cylinder. The first stage of the medium pressure cylinder has a rotating diaphragm, which performs protective functions, just as the blocking dampers installed in the steam lines to the medium pressure cylinder. The rotating diaphragm can also be used to control the pressure following the high pressure cylinder.

A specific feature of the flow-through section of the turbine is the fact that the steam to low pressure cylinder 2 is bled off from the medium pressure cylinder ahead of the intermediate section, and that to low pressure cylinder 1, after the intermediate section. This solution permits a reduction in the height of the vanes of the intermediate section, and increases turbine operating economy.

Regenerative preheating of the feedwater in the TK-450/500-68 turbine is accomplished sequentially in the main ejectors, the bleed-off ejectors from the seals, by one mixing type PND [low pressure heater], four surface type PND's and an increased pressure deaerator with subsequent preheating by virtue of the mixing of the feedwater with the drain condensate of the SPP heating steam. The thermal circuits of the TK-450/500-60 turbine is supplemented with one PVD.

Single stage intermediate superheating of the steam was adopted in the engineering design.

The mains water is preheated sequentially in two stages using heating with the steam from the heating bleed lines; to obtain a higher temperature, two more bleed lines are provided at pressures of 8-10 and 22-25 kgf/cm^2.

The steam turbine section of the NTS noted that the necessity of designing the heat supply turbine with a capacity of 500 MW for nuclear TETs's was due to the wide scale use of nuclear fuel for the generation of electrical power and heat. The calculated economic impact from the use of nuclear TETs's with TK-450/500 turbines in the European portion of the USSR will amount to 40 million rubles (for a power unit consisting of two turbines with a 1,000 MW reactor). The fraction of the economic savings due to the turbine installation amounts to about 60 percent.

The engineering design of the TK-450/500 turbine was worked out in accordance with the technical specifications for the developmental work and the decisions of the NTS of the Ministry of Power Engineering Machines and the Ministry of Energy of the USSR in accordance with the draft project plan for the TK-450/500-60 turbine. The project design was worked up in sufficient volume and at a high technical level. The turbine being planned is a custom made one in terms of its characteristics and does not have any analogs in world turbine construction.

The section noted the expediency of employing an electrohydraulic, decoupled control circuit for the rotational speed, power and steam bleed lines, which increases the precision in the maintenance of the parameters being controlled and the level of automation of the turbine installation as a whole with a simultaneous substantial simplification of the hydraulic section (as compared to existing control configurations for heat supply turbines), as well as the expediency of using additional steam bleed-offs in the turbine to increase the heating of the mains water, something which assures universality in the utilization of the turbines, taking into account the specific features of ATETs's (considerable remoteness from the heat consumers, etc.).

As the NTS section noted, it is necessary that the production of the prototype TK-450/500 turbine be assured prior to completing the reconstruction, at existing production facilities, with the installation of two to three units of the production process equipment, while to assure the series production of the TK-450/500 turbines at the planned volume, it is necessary to build specialized facilities.

The steam turbine section recommended the approval of the engineering design of the turbine for further developmental work. With the execution of the working project plan, the "Turbomotornyy zavod" ["turboengine plant" production association, in conjunction with the Scientific Production Association of the Central Scientific Research Institute for Technology and Machine Construction and the All-Union Planning and Technological Institute for Power Engineering Machinery should consider the possibility of utilizing new production process equipment and the modern metallurgical base of the sector (stamping and forging presses, installations for obtaining a pure metal, etc.).

The section considers it expedient to employ elevated pressure detection devices ahead of the SPP and in the chambers of the heating bleed-offs by means of acting on the controlling and stop valves of the turbine. In this case, safety valves at 20 percent of the maximum steam flow rate in the turbine are to be provided. Considering the fact that such design solutions have been adopted for the nuclear turbines of the "Leningrad Metals Plant" production association and the "Khar'kov turbine plant" production association, it was recommended that engineering supervision be turned over to the NPO Ts KTI [Scientific Production Association of the Central Scientific Research and Planning and Design Institute for Boilers and Turbines imeni I.I. Polzunov], drawing on turbine plants to approve the adopted design solutions in the Gosgortekhnadzoi [State Scientific and Engineering Inspectorate for Mining Affairs].

The section approved the additional steam bleed-off for increased preheating of the mains water (up to 170-210° C) provided in the engineering design, with the capability of increasing the thermal load on the turbine up to 600-700 GCal/hr, and when necessary, supplying steam to consumers, something which essentially transforms it into a multifunction heating turbine installation. It is recommended that the nominal level of the thermal load of the turbine at 450 GCal/hr be authorized (including the case of an elevated preheating temperature for the mains water).

The system recommended the use of noncombustible oil of the OMTI type, with the supply of the same oil for the feed turbopump from the oil systems of the main turbine, for the lubrication and control system. To preclude the intrusion of water into the oil and oil into the water, a dual circuit cooling system is adopted for the oil coolers, where the water pressure in them is below the oil pressure.

The "turboengine plant" production association, in conjunction with the NPO TsKTI, the Moscow Order of Lenin Power Engineering Institute and the

All-Union Order of the Red Banner of Labor Heat Engineering Institute imeni F.E. Dzerzhinskiy recommended the continuation of work to increase the operating economy of the low pressure cylinders and assure the capability of turbine operation in the nonheating period with the full flow rate of live steam when the pressure in the condenser is increased up to 0.16-0.18 kgf/cm^2. Turbine operation is to be studied at increased pressure in the condenser, including tests of the T-250/300-240 turbine under operational conditions.

The section recommended providing units with horizontal and vertical steam generators having the same circuit for feeding the heating steam condensate of the main supply water preheaters for the turbine installations (pumps in the main condensate line without cooling and cleaning). Emergency drainage (in the case of poor quality condensate) is to be provided in the turbine condenser expander. The same quality material for the pipes of the heat exchanger surfaces is to be adopted for the heat exchangers of the turbine installations of the units (with both vertical steam generators and with horizontal ones).

The section recommended that the TK-450/500 turbine be rated at the highest quality category based on the planned indicators.

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ELECTRIC POWER AND POWER EQUIPMENT

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POWER STATIONS AND POWER EQUIPMENT ECONOMY

Moscow ENERGETIK in Russian No 11, Nov 79 pp 1-3

[Article by S.Ye. Shitsman, Candidate of the Engineering Sciences]

[Text] The specific fuel consumption of a power system depends on the level of electric power station operating economy and on the fraction of electrical power output of each electric power station, i.e., on the structure of electric power generation.

The average specific fuel consumption for a power system is determined from the formula:

$$b_c = \frac{b_1 Э_1 + b_2 Э_2 + \dots}{Э_1 + Э_2 + \dots} = \frac{\Sigma b_i Э_i}{Э_c}, \text{ г/(кВт·ч)}, \qquad \text{g/KWH} \qquad (1)$$

where b_i is the specific fuel consumption of the i-th electric power station in g/KWH; $Э_i$ is the electric power output of the i-th electric power station, millions of KWH; $Э_c$ is the total electric power output of the system, millions of KWH.

The contribution of an individual electric power station to the economy of a system over a period being considered is taken, at the present time, as equal to the savings (or over expenditure), achieved by the electric power station itself, and is defined by the formula

$$\Delta B_i^{эк} = (b_i^а - b_i^б) Э_i^а, \text{ т.} \qquad \text{tons} \qquad (2)$$

The superscript a applies to the period being analyzed, and the superscript Б applies to the base period. The quantity ΔB_i with a "minus" sign means a fuel savings, and with a "plus" sign, it means an overconsumption of fuel at the electric power station in the period being analyzed as compared to the base.

The influence of a change in the economy of an individual i-th electric power station on the dynamics of the specific consumption with respect to the association amounts to:

$$\Delta b_i^{эк} = \frac{\Delta B_i^{эк}}{Э_c^{а}} = \frac{(b_i^{а} - b_i^{б})\,Э_i^{а}}{Э_c^{а}}, \qquad \text{g/KWH} \qquad (3)$$

However, the estimate of the contribution of each electric power station to the dynamics of the specific consumption of the association based on formulas (2) and (3) is incomplete, since the additional influence of a variation in the output of electrical power by an electric power station on the specific consumption of the association is not taken into account. The greater the specific consumption of the i-th electric power station deviates from the average specific consumption for the association in the base period, the more significant the influence of the change in the output of electrical power, i.e., the structural influence of this electric power station on the dynamics of the association operating economy.

As can be seen from formula (1), an electric power station having a specific fuel consumption higher than the system average, when electrical power output increases, yields an increase in the average specific consumption of fuel for the system; when the electric power output is reduced, it yields a reduction in the average specific consumption. For an electric power station with a specific consumption below the overall system level, the results are reveresed.

The calculation of the structural influence of individual electric power stations is made for the case of a constant specific fuel consumption for each electric power station at the base period level. Taking formula (1) into account, we define the structural influence of each electric power station on the dynamics of the system economy as:

$$\Delta B_i^{стр} = (b_i^{б} - b_c^{б})(Э_i^{а} - Э_i^{б}), \text{ т}, \qquad \text{tons} \qquad (4)$$

or

$$\Delta b_i^{стр} = \frac{\Delta B_i^{стр}}{Э_c^{а}} = \frac{(b_i^{б} - b_c^{б})(Э_i^{а} - Э_i^{б})}{Э_c^{а}}, \qquad \text{g/KWH} \qquad (5)$$

The total influence of individual electric power stations on the dynamics of the system economy is expressed by the sum of the quantities represented by formulas (2) and (4) and (3) and (5):

$$\Delta B_i = \Delta B_i^{эк} + \Delta B_i^{стр} = (b_i^{а} - b_c^{б})\,Э_i^{а} - (b_i^{б} - b_c^{б})\,Э_i^{б}, \text{ т}, \qquad (6)$$

$$\Delta b_i = \Delta b_i^{\text{эк}} + \Delta b_i^{\text{стр}} = \frac{\Delta B_i}{Э_{\text{с}}^{\text{а}}} = \frac{b_i^{\text{а}} - b_{\text{с}}^{\text{б}}}{Э_{\text{с}}^{\text{а}}} Э_i^{\text{а}} - \frac{(b_i^{\text{б}} - b_{\text{с}}^{0})}{Э_{\text{с}}^{\text{а}}} Э_i^{\text{б}}, \text{ г/(кВт·ч)}. \qquad \text{g/KWH} \qquad (7)$$

The volume of electrical power generated by each electric power station of the system is regulated by the dispatcher load control charts, which provide for predominant loading of the more economic electric power stations. However, the dispatcher load control charts themselves depend on the level of operation of each electric power staion.

The problem consists in achieving the maximum possible electric power output from those electric power stations which have a specific fuel consumption below the association average, and to limit within the range of the plan for the power association the output at electric power stations where the specific fuel consumption is above average.

On one hand, the solution of this problem consists in increasing the number of hours of utilization of the economical equipment, something which includes efficient planning of the equipment repair schedules, increasing repair quality, the maximum possible curtailment of downtime and increasing the working capacity of the economical equipment, priority supply of it with scarce fuel, accelerating the bringing on-line and rapid mastery of new equipment, and on the other hand, in the maximum possible reduction in the number of hours of utilization of the poor economy equipment, something which includes increasing its flexibility and providing for the possibility of deep unloading, despite the increase in the specific fuel consumption in this case.

An analysis of the influence of the output volume of each electric power station on the dynamics of the power association economy promotes an improvement in the fuel utilization on the energy association scale.

An analysis has been made over several years in the Mosenergo [Moscow Area Power System Administration] system of the influence of individual electric power stations and the influence of a change in the condensation and heating output of electrical power on the dynamics of the systems specific fuel consumption.

A systematic analysis has made of the influence of each electric power station on the execution of the plan assignments by the system regarding the specific fuel consumption in the year being analyzed. For this, the plan contribution of each electric power station to the dynamics of system economy provided by the plan is determined based on the formulas cited here for the start of the year being analyzed. Then, the actual contribution of each electric power station to the dynamics of system economy over the period elapsed since the start of the year is determined on a monthly basis.

By way of example, the results of calculating the dynamics of the indicators for four electric power stations (of 18) on the dynamics of system economy over 10 months of 1978 are shown in the table.

The plan assignments with respect to the dynamics of the operational economy of four electrical power stations are given in the first half of the table, as well as for the system as a whole over all of 1978. The actual results of the influence of each electric power station on the dynamics of the system operational economy over 10 months of 1978 are given in the second half.

A comparison of the data obtained over 10 months with the plan assignments for the year permits an assessment of the execution of the plan assignments by each electric power station and the system as a whole. Thus, for example, at electric power station No. 1, the annual plan provided for increasing the electric power output by 482 million KWH, and reducing the specific fuel consumption by 4.9 g/KWH. A condensation electric power station has a specific fuel consumption considerably higher than the system average, and for this reason, the plan provided for conventional fuel over consumption with respect to the system level in the amount of 42,775 tons of conventional fuel, including the savings due to the planned reduction in the specific consumption of conventional fuel in the amount of 15,930 tons and the over consumption of conventional fuel due to the increase in the electrical power output in the amount of 58,705,000 tons of conventional fuel.

Over the past 10 months of 1978, the electric power station increased the electric power output by 297 million KWH, reduced the specific consumption by 6.5 g/KWH and as a result came up with an over expenditure of conventional fuel of only 19,031 tons or 0.34 g/KWH, instead of the 0.77 g/KWH provided by the annual plan. The achieved results make it possible to give a positive rating to the operation of the electric power station over the period under consideration.

Things are different at electric power station No. 2. The plan for 1978 called for the electric power station to increase the electrical power output by 82 million KWH and reduce specific fuel consumption by 4.8 g/KWH. This TETs, having a significant fraction of the electric power output in the heating cycle, has a specific fuel consumption considerably below the system average. The planned contribution of this electric power station to the system's savings amounts to 12,801 tons of conventional fuel in savings, including 8,376 tons through a reduction in specific fuel consumption and 4,424 tons by increasing the electrical power output. Over the indicated period, the electric power output did not increase, but fell off by 12 million kilowatts, and the specific fuel consumption dropped by only 3.5 g/KWH. As a result, the contribution of the electric power station to the system economy amounted to only 4,165 tons of conventional fuel, including the overconsumption which because of the

Electric Power Station and System Indicators	The Electric Power StationsNumbers				For the System as a Whole
	1	2	3	4	
Plan assignment for 1978:					
$Э^a$, millions of KWH	3,251	1,745	6,665	7,105	55,243
b^a, g/KWH	396	220	213.1	242.5	277
Actual indicators during 1977:					
$Э^б$, millions of KWH	2,769	1,663	6,245	6,531	52,446
$b^б$, g/KWH	400.9	224.8	207.1	248	279
The planned contribution to system economy, ΔB, tons:	42,775	-12,801	9,784	-56,879	-111,999
Including that due to the economy of a station, $\Delta B^{эн}$	-15,930	-8,376	39,990	-39,078	-70,681
Including that due to the structure, ΔB^{str}	58,705	-4,424	-30,206	-17,801	-41,318
The planned influence on the dynamics, Δb, g/KWH:	0.77	-0.23	0.18	-1.03	-2.0
Including that due to the economy, $\Delta b^{эн}$, g/KWH	-0.29	-0.15	0.72	-0.71	-1.25
Including that due to structure, Δb^{str}, g/KWH	1.06	-0.08	-0.54	-0.32	-0.75
Actual indicators over 10 months of 1978:					
$Э^a$, millions of KWH	2,628	1,331	5,391	5,656	44,234
b^a, g/KWH	394.2	232.6	220.9	253	281.9
Actual indicators over 1977:					
$Э^б$, millions of KWH	2,331	1,343	4,960	5,202	42,275
$b^б$, g/KWH	400.7	236.1	213.3	253.5	285.8

Electric Power Stationsand System Indicators	The Electric Power Station Numbers				For the System as a Whole
	1	2	3	4	
Actual contribution to system economy, ΔB, tons:	19,031	-4,165	12,645	-14,398	-158,998
Including that due to the economy of a station, $\Delta B^{ЭН}$, tons	-17,082	-4,659	40,972	-2,828	-107,958
Including that due to structure, ΔB^{str}, tons	36,113	494	-28,327	-11,570	-51,040
Actual influence on the dynamics, Δb, g/KWH:	0.34	-0.08	0.23	-0.26	-2.88
Including that due to the savings $\Delta b^{ЭН}$, g/KWH	-0.31	-0.09	0.74	-0.05	-1.96
Including that due to structure Δb^{str}, g/KWH	0.65	0.09	0.51	-0.21	-0.92

reduction in the output amounts to 494 tons. Thus, the electric power station, because of the failure to meet the output plan (unplanned equipment shutdowns and reduced working capacity) produced a deficiency of about 5,000 tons of conventional fuel in the indicator for system economy, something which was previously not taken into account in estimating the operational economy of the electric power station. The data of the table make it possible to perform a similar analysis for electric power stations Nos. 3 and 4, as well for the system as a whole.

The current analysis of the dynamics of operating economy can be carried out in a centralized fashion with respect to the association, or for an electric power station, having all of the information available needed for making the calculations for the given electric power station. A special standard, SM-15-1-78, approved by the managing REU [not further defined] was introduced in Mosenergo for the performance by each electric power station of an analysis of its own influence on the dynamics of system economy. The involvement of electric power station personnel in the analysis of the dynamics of system economy expands the outlook of station personnel, increases their responsibility for the dynamics of system operating economy and strengthens the efficiency and significance of the analysis.

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ELECTRIC POWER AND POWER EQUIPMENT

GENERAL PLAN FOR THE LENINGRAD HEAT SUPPLY

Moscow ENERGETIK in Russian No 11, Nov 79 pp 35-36

[Article: "In the Scientific and Engineering Council of the USSR Ministry of Energy. The General Scheme of the Leningrad Heat Supply over the Period up to 1990"]

[Text] The scientific and engineering council has considered the general plan for the Leningrad heat supply, developed in accordance with the decision of the Executive Committee of the Leningrad City Soviet with the Northwest Branch of the All-Union Scientific Research and Planning Institute of the Power Engineering Industry Administration.

Leningrad is the largest scientific, cultural and industrial center of the Soviet Union with a population of more than four million. More than 1,000 industrial enterprises and associations are located within the city limits.

The thermal supply for the city comes from seven TETs's [Central Heat and Electric Power Stations] of the Lenenergo Regional Power Administration, four industrial TETs's, 34 regional boiler facilities, 520 industrial boiler facilties and 1,850 small residential-public sector boiler facilities. The installed thermal capacity of all heat sources as of 1 January, 1976 amounted to 21,300 Gcal/hr.

The installed electrical power of all Leningrad TETs's on 1 January, 1976 amounted to 1,487 MW, while their thermal capacity was 6,800 Gcal/hr.

The heat output from the TETs's is delivered to consumers via an open heat supply system at design feed and return water temperatures of 150-70° C. These consumers are connected in a dependent system configuration, i.e., by means of direct water feed from the heating mains to a heating system. The open heat supply system has a number of substantial drawbacks.

Water of irregular quality is fed for the hot water supply. The water treatment units and hot water accumulators available at TETs's for the case of the peak distributions of the hot water supply water are inadequate to maintain the normal mode in the heating mains, and as a result, water from the water line, and in some cases even directly from the river, is used for make-up water for them.

The heating mains have been run primarily underground in a channelless configuration for the city. The overall length of the heating line routes from the TETs's amounts to 1,053 km, including 988 km of water lines and 65 km of steam lines. The overall length of the heating line routes from the boiler facilities of the fuel and power engineering administration of the Leningrad City Soviet amounts 678 km, and of them, 81 km are trunk lines.

The overall demand for heat by the city has been determined as 31,200 Gcal/hr in 1985 and 37,600 Gcal/hr in 1990.

Variants have been considered for the construction of new and the expansion of the existing heat sources of the TETs's and boiler facilities, as well as the trunk heating lines, to cover the operational heating loads. In this case, the ecisting open heat supply system with the heat consumers connected for heating in a dependent configuration has been retained in the operation. It is recommended that the TETs-5, TETs-15, the Severnaya TETs [Northern TETs], the Yuzhnaya TETs [Southern TETs], the construction of a nuclear TETs and a number of boiler facilities in the rayons of the city be expanded.

Along with this, technical solutions have been proposed which are directed towards the further centralization of the heat supply, improving the reliability and the engineering and economic level of heat supply system operation.

Of these decisions, the major ones are as follows: the installation of modern power equipment at the TETs's; the disassembly of mdeium pressure turbine sets with an overall electrical capacity of 248 MW, which have poor operating economy, and 21 boiler units with an overall heat productivity of 825 Gcal/hr; taking small obsolete and obsolescent boiler facilities out of service which have an overall heat productivity of 3,550 Gcal/hr (8,900 servicing personnel will be freed); the construction of connecting lines between heating mains within the bounds of a heating region and between heating regions and heat sources; imparting a ring configuration to the heating mains; and the introduction of an automated dispatcher control system for the heating mains.

The scientific and engineering council adopted the following main resolutions on the basis of the work which was presented.

1. Base the expansion of the Leningrad heat supply to the maximum possible extent on the combined generation of heat and electrical power.

2. Expand existing TETs's for the Leningrad heat supply in the following amount:

TETs-5: by means of installing three T-180-130 type units with an overall capacity of 540 MW, with an increase in the design heat output by 1,500 G/cal/hr, providing for the possibility of further expanding it;

TETs-15: by means of installing two T-110-130 type units with an overall capacity of 220 MW with an increase in the design heat output by 360 Gcal/hr, and working out the possibilities of replacing obsolete equipment with modern equipment;

TETs Severnaya: by means of installing two T-175-130 type units with an overall capacity of 350 MW with an increase in the design heat output by 1,000 Gcal/hr, providing for the possibility of further expanding it;

TETs Yuzhnaya: bv means of installing T-250/300-240 units with an overall capacity of 500 MW, with an increase in the design heat output by 1,200 Gcal/hr, and providing for its further expansion.

3. Completely rebuild TETs-2, located in the Smol'nin rayon, to provide for centralized heat supply from it for the central region of Leningrad, with the subsequent elimination of about 500 small boiler facilities in this region.

4. Construct the new Northwest TETs at the built-up site in the Konnaya Lakhta region during the 11th and 12th Five-Year Plans, with the installation there of five to six T-180/215--30 units with a design heat output of 3,000-3,300 Gcal/hr, with through-transportation of the heat from it to the peak boiler facilities using a single pipeline configuration.

5. Use shale oil, which is planned for production in Estonia, as the main fuel for the TETs-2 and the Northwest TETs.

For this purpose, limit the power of the electric power station, planned for construction in conjunction with the installation for the shale refining equipment, by using only the resulting gas, with the complete forwarding of the entire yield of shale oil to the Leningrad Power System.

6. Adopt natural gas (until the arrival of the shale oil) as the major fuel for the TETs's being expanded, as well as temporarily for the first stage of the TETs-2 and the Northwest TETs.

7. Orient the further development of the centralized heat supply of Leningrad towards nuclear sources in the future after 1990.

8. Provide for the implementation of the following measures directed towards increasing the reliability of heating mains and the heat supply

consumers: the construction of large regulating stations, which provide the heat supply for an entie microrayon (a large block), outfitted with automation equipment, remote control and monitoring; provide for combined operation of the heat sources; assure 100% back-up in the water feed from the municipal water line to the TETs.

9. Increase the productivity of the deaeration installations at TETs's designed so that it exceeds the water intake and the water losses in the mains by 20-25% with a corresponding increase in the water feed from the municipal water line, install an additional unit at each TETs to clean the water from the water line of organic impurities; later, change over to the use of an independent configuration for the connection of heating systems while retaining the open system for hot water supply.

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ELECTRIC POWER AND POWER EQUIPMENT

UDC 620.97

SECONDARY POWER ENGINEERING RESOURCES FOR USSR INDUSTRY

Moscow VTORICHNYYE ENERGETICHESKIYE RESURSY PROMYSHLENNOSTI SSSR in Russian 1978 signed to press 25 May 78 pp 2, 319-320

[Annotation and Table of Contents from the book by S.P. Sushon, A.G. Zavalko and M.I. Mints, Energiya Publishers, 1978, 5,000 copies, 320 pages]

[Text] General questions of the organization of secondary power engineering resource utilization in the industry of the USSR are set forth in the book; the characteristics of the state of the art and the prospects for their utilization in energy intensive sectors of industry are given; characteristics are cited for the utilization schemes and the structural designs of the equipment employed. Questions of planning are treated as well as the economics of the use of secondary energy resources.

The book is intended for engineering and technical workers, and economists of industrial enterprises, workers at scientific research and planning institutes, as well as specialists of planning and management organs, engaged in questions of the economy and utilization of fuel.

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FUELS AND RELATED EQUIPMENT

REMOTE STUDY OF GEOLOGICAL STRUCTURE OF OIL AND GAS BEARING REGIONS

Moscow VESTNIK AKADEMII NAUK SSSR in Russian No 10, Oct 79 pp 69-78

[Article by V. I. Gridin, Candidate of Geological and Mineralogical Sciences, and N. A. Yeremenko, doctor of geological and mineralogical sciences: "Remote Methods of Studying Geological Structures of Oil and Gas Bearing Regions"]

[Text] In the last decade an increase in the consumption of various types of mineral resources, especially oil and gas, has been responsible for accelerated development of new high-altitude and space methods for studying the Earth's natural resources. Such remote study of the geologic structure of oil bearing regions is based on the close dependence between the processes taking place in the Earth's crust and on the Earth's surface, the manifestation of this natural principle in today's landscape and the direct reflection of features of the past in remote exploration data. There is no longer any doubt that the different components of the landscape reflect, absorb or generate electromagnetic radiation to various degrees.

Many geologic structures lying at different and sometimes considerable depths are displayed in the data obtained using electromagnetic survey methods. This pertains mainly to faulted and folded structures formed as a result of tectonic movements. "Displaying ("illuminating") deep-level structures on the surface is done by way of its mechanical distortion relative to the distortions of deeper strata and through its geochemical changes connected with upward flows of the gaseous and liquid products of conversion of the substances of deep-level strata of the Earth's crust and upper mantle."[1] At the same time, changes in the mass of the crust cause variations in the gravitational, magnetic, thermal and other physical fields of the Earth. Local variations in these fields predetermine corresponding rearrangement

1. V. I. Makarov and L. I. Solov'yeva. "A Cross-section of the Earth's Crust and the Problem of Displaying Its Deep-Level Elements at the Surface (example--the Tyan'-Shan and Turanskaya Ranges)," in "Issledovaniye prirodnoy sredy kosmicheskimi sredstvami" [Studies on the Natural Environment Using Space Equipment], GEOLOGIYA I GEOMORFOLOGIYA, Vol. 5, Moscow, 1976.

(or reshaping) of the landscape's components and become one of the important reasons for their geochemical change. The reaction of landscape formation processes to mechanical changes and to resultant variations in the physical fields leads to the formation of specific landscape components (which serve as indicators of the deep-level structure) or to the emergence of local, sometimes barely perceptible, anomalies in the structure of its background components. These indicators and anomalies reflect the characteristics of the deep-level structure of the Earth's crust in remote survey data.[2]

The history of remote method application for oil exploration work is already characterized by definite successes in spite of the comparative youth of the whole trend toward aerospace study of Earth's natural resources.

Abroad, mainly in the United States, extensive use of remote methods in surveying for oil and gas formations began as long as 50 years ago. In the beginning only black-and-white photography was used, then spectrum-band and colol film. The global nature of remote-method application and the drive to increase its efficiency led to the use not only of the visible part of the spectrum, but also other electromagnetic frequencies. Radar, infra-red, radiothermal and other remote methods appeared without which topographical, geologic, geologic engineering, magnetic, ground and other types of surveying would be impossible.

Along with them were developed complex multi-band photography systems which called for studying the spectrophotometry of the targets being investigated and also determining its effect on subsequent processing of remote survey data. Television systems became widely used for continuous surveying of the Earth with real time data transmission by radio channel. The enormous amount of information obtained made it possible to develop and adopt equipment for mechanizing and automating data decoding processes and also to train specialists with appropriate profiles. Efficiency in accomplishing this whole set of operations, an indubitable economic return and other advantages of remote methods are attracting the attention of a whole series of oil firms who also finance a considerable part of work on the USA space program.

In the Soviet Union aerial methods are used to solve regional geologic problems and primarily for geologic surveying of barren territories. Since 1966 aerial methods have become obligatory in geologic surveying, geophysical

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2. See: V. I. Gridin. "Some Questions on the Theoretical Foundations of Aerial Geologic and Morphometric Methods," in "Stratigrafiya, litologiya i poleznyye iskopayemyye BSSR" [Stratigraphy, Lithology and Mineral Resources of the BSSR], Minsk, 1966. and "On the Effect of Local Variations in the Earth's Physical Fields on the Nature and Intensity of Relief-forming Processes (example--the BSSR)," in "Sovremennyye ekzogennyye protsessy" [Contemporary Exogenous Processes], Kiev, 1968.

and exploratory work conducted by organizations of the USSR Ministry of Geology. Experimental and methodological aerogeologic research began in 1966-1968 on a system for the Ministry of the Oil Industry. It was carried out under the direction of the Institute for Geology and Development of Radioactive Minerals (IGiRGI). The scientific plans of the IGiRGI--as the chief institute of the sector--are the most important, key plans for each of the aerospace research directions and also those having overall methodological significance on the subject. A considerable part of the research is being done with modern programs coordinated both with the appropriate subdivision of the Ministry of the Oil Industry and with the organizations and businesses of other ministries and departments. Such as organizational set-up seemed most efficient for developing new remote methods and assimilating their results.

With the launching of the first man-made Earth satellite, the first space flight of Yu. A. Gagarin, the first photographs of Earth from space taken by G. S. Titov and the operation of the first automatic and manned orbital laboratories, the Soviet Union opened a new, space era in the study of Earth's natural resources. The development of technical equipment for space photography made it possible to obtain photographs with a resolution which met contemporary needs for the performance not only of regional but also of detailed oil exploration work. It became possible to obtain fundamentally new information and to significantly justify the process of studying oil and gas bearing regions.[3]

In "Basic Directions in Development of the USSR National Economy in 1976-1980" adopted by the 25th CPSU Congress plans were made to considerably expand the use of high-altitude and space photographic surveying in studying Earth's natural resources. In implementing the resolutions of the Congress scientific research and experimental work was expanded on the creation of new remote methods, their testing and adoption in oil exploration work.

Based on positive experience in the use of remote survey data in the Pripyatskaya, Dneprovsko-Donetskaya and Ferganskaya oil and gas fields, further refinement and assimilation of remote survey methods for oil formations were anticipated by the Ministry of the Oil Industry. A system of multiple specialized subdivisions was organized in production associations for this purpose. The task of these subdivisions is to conduct experimental method and experimental production research on introducing aerial and space methods under the actual conditions of regions under investigation.

In organizing the specialized subdivision system the Ministry of the Oil Industry encountered certain difficulties caused by a dearth of specialists with suitable profiles and qualifications who were not being specifically

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3. See: "USSR Oil and Gas Bearing Capacity (explanatory notes to a map of USSR Oil and Gas Bearing Capacity to a 1:2,500,000 scale)."

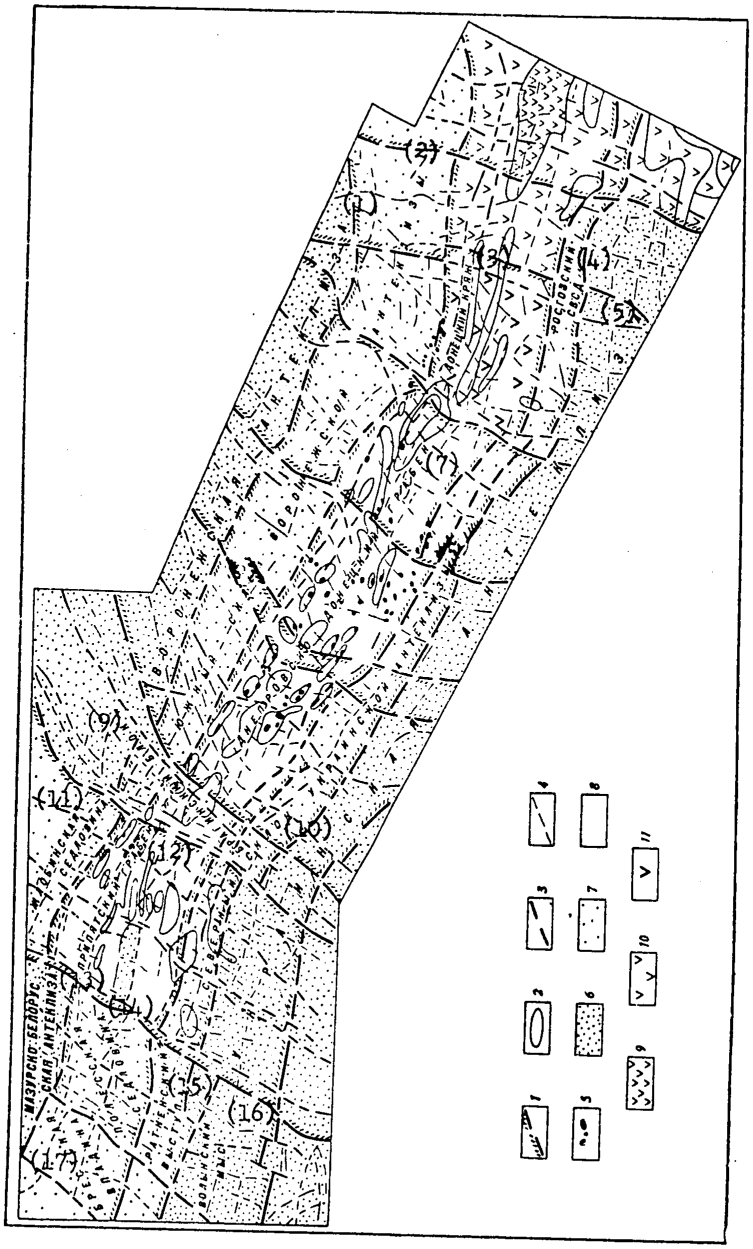
trained by the vuzes and technical schools. To retrain geologists and geophysicists, continuously-running courses were set up to increase qualifications in aerospace methods. During 1976-1978 studies on pre-field, field and laboratory stages of work were conducted for 63 specialists.

The Ministry of the Oil Industry aerospace department is carrying out a wide range of studies. They include development and testing of methods and techniques for remote study of oil and gas bearing regions as applied to solving oil exploration problems, refining known and originating new directions for geologic work to provide a front for future oil exploration, more accurate specification of the structure of known oil exploration, more accurate specification of the structure of known and discovery of new exploration targets with concrete recommendations given for performing geophysical and drilling work. Scientific methods and technical procedures of remote surveying are employed experimentally by specialized territorial subdivisions of the Ministry. At present initial results of such studies have been obtained in a number of oil and gas bearing provinces and regions as well as data on their testing by traditional geologic and geophysical methods. These data make possible evaluation of the overall geologic and economic impact of aerospace research conducted in oil exploration in our country.

The most impressive results were obtained in the Dneprovsko-Pripyatskaya province. Through regional surveys done in cooperation with the Prirod Godtsentr [State center] a diagram of the tectonic structure of the Pripyatsko-Dneprovski-Donetskiy avlakogen was composed (Fig. 1).

The structure of the northern and southern plutonic fractures of this avlakogen as well as of the regional longitudinal and transverse disjunctive interruptions has been described more precisely. As the decoding data showed, the productive sediments of the plutonic fracture zones are collected in semi-anticlinal folds. Oil exploration work conducted in Ozeryanskaya, Prokopenkovskaya and other sites showed that these folds may indicate commercial hydrocarbon deposits. Comparisons of the remote survey data with results of geologic-geophysical studies have made possible recommendations for conducting oil exploration in deep-level fracture zones.

The avlakogen is broken into huge blocks by longitudinal and transverse disjunctive interruptions. The combined vertical amplitudes of the neotectonic block movements reaches 110-130 m. With productive horizons having an effective thickness of several tens of meters, this movement may have had a definite effect on rearranging the hydrocarbon deposits, which makes study of the neotectonic activity of the examined structural forms possible as one of the criteria for estimating the oil and gas bearing potential. The large block structure of the Pripyatskaya oil field has been confirmed and detailed in regional aerospace work. Analysis of its results as compared to the data of preceding and subsequent geologic and geophysical studies of the eastern half of the field will make possible accurate determination of the location and structure of the already known uplift zones.



KEY:

1. Voronezhskaya anticline
2. Southern slope of the Voronezhskaya anticline
3. Doretskiy ridge
4. Rostovskiy dome
5. Ukrainskaya anticline
7. Dneprovskio-Donetskiy graben
9. Braginskiy block
10. Northern slope of Ukrainskaya anticline
11. Zhlobinskaya saddle
12. Pripyatskiy graben
13. Mazursko-Belorusskaya anticline
14. Polesskaya saddle
15. Ratnenskiy shelf
16. Volynskiy cusp
17. Brestskaya basin

Extended photoanomaly zones relative to a series of semianticlinal folds as verified by small-amplitude disjunctive interruptions have been detected by aerospace methods on the sloping monoclinal sides of these zones as well as in the depressions of the Pripyatskiy trough. The new photoanomaly zone has been identified as 31. Thirteen were recommended for first-priority testing. Ten zones with independent intersections were tested and nine confirmed.

Longitudinal and transverse zoning was identified using results of comprehensive processing of remote and geologic-geophysical data on the Pripyatskaya depression. Longitudinal neotectonic uplift zones, according to aerospace data, coincided as a whole with uplife zones in the productive horizons detected by seismic survey and drilling. The transverse neotectonic uplife zones bounded by disjunctive interruptions with northeastern strike were not detected by previous geologic-geophysical studies. According to aerogeoligic study data the trasverse uplift zones in the neotectonic surface structure appear to overlap longitudinal zones. In places where transverse and longitudinal zones intersect there are local structures characterized by maximum uplift amplitude in Neogenic anthropogenic time. Comparison of the mapped disposition of the transverse neotectonic uplift zones with available data on oil bearing capacity suggests that all of the presently known commercial oil formations are located within the indicated zones or on their slopes. The noted natural relationship between oil bearing capacity and the characteristics of neotectonic movement is based on a comparatively small amount of factual data and needs further corroboration. But even now the transverse neotectonic zoning must be calculated in order to identify priority oil exploration targets and ascertain their scope.

The transverse disjunctive interruptions and their zones also have an independent significance for oil exploration. They separate local structures from each other and break them up into separate blocks. In particular, they divide the periclines of oil and gas formations and in this case may serve as a tectonic mask of the oil strata. An example is the Ozeryanskoye uplift of the Dneprovsko-Donetskaya gas and oil field which is divided into a series of blocks by transverse fractures. A structural diagram of this site using aerogeologic data is given in Figure 2.

Successful detailing of known and identification of new promising directions for oil exploration have been accomplished with the use of obtained data.

There are plans to conduct exploration in regions of anomalies relative to structural complexities in the overburdens of monoclinal limbs of uplift zones, of periclines in oil and gas formations intercepted by transverse fractures and and of anomalies relative to structural forms in the northern and southern deep-level fracture zones.

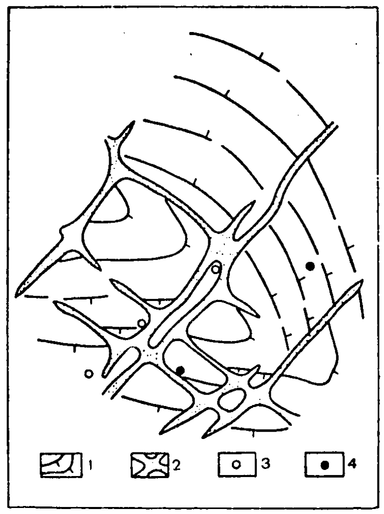


Fig. 2. Structural Diagram of Ozeryanskaya Site Using Aerogeolic Data

The promise of the indicated directions has been partially confirmed by subsequent seismic surveying and drilling.

The outcome of detailed aerospace studies in the Dneprovskio-Pripyatskaya gas and oil bearing province may be illustrated by the example of one of the experimental work sections located in the northwestern part of the Dneprovsko-Donetskaya field. Comparison of the results of aerospace and preceding and subsequent geologic-geophysical work on this section is given in Figure 3.

The section is located in a region of oil production development. It includes two oil and gas pools. For a long time promising formations for oil and gas explorations have not been detected here by traditional geologic-geophysical work. However, 13 local structures and their blocks have been determined to be promising in an oil exploration connection to one degree or another. Photoanomalies corresponding to an indicated exploration target have been detected in the section by aerospace studies. All 13 known exploration targets were displayed in remote survey data with full or partial coincidence of the contours. In addition, 12 photoanomalies were detected. Also identified were certain governing principles in the distribution of the exploration targets. The longitudinal and transverse zoning were outlined and the important role of disjunctive interruptions with a northwestern and northeastern strike in the structures of the studied territories was established. Taking into account the indicated governing principles in subsequent oil exploration work, six photoanomalies were recommended for first priority consideration.

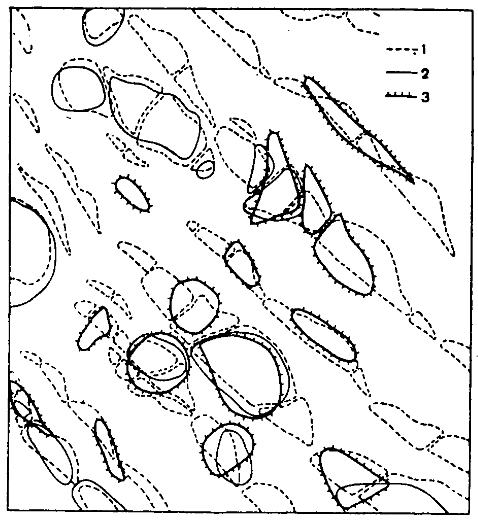


Fig. 3. Comparison of Results of Detailed Aerospace Studies and Preceding and Subsequent Geologic-Geophysical Studies in the Dneprovsko-Donetskaya Gas and Oil Field

KEY:

1. Contours of photoanomalies detected by aerospace survey methods.
2. Contours of local oil exploration targets detected by previous geologic-geophysical work.
3. Contours of oil exploration targets detected by subsequent geologic-geophysical work.

By subsequent geologic and geophysical work it has been ascertained that of 11 photoanomalies tested, 9 were connected with coal deposits and 2 anomalies were not confirmed by seismic survey data. In four of the photo-anomalies parametric and exploratory drilling was done. Oil and gas pools were discovered in the Belousovskaya and Svetlichnaya anomalies. Gas inflow and a core sample with oil were obtained in the Ozeryanskaya anomaly by reservoir-testing equipment.

All of the just listed facts indicate that even in regions developed by the oil industry and characterized by considerable (although irregular) study, integration of remote and traditional methods will make it possible to obtain new information about deep-level structures and on their basis to more precisely determine the location of known oil exploration targets and establish the reliability of new targets.

The confirmation factor for photoanomalies with subsequent geologic-geophysical work reaches 0.8-0.9 judging by the results of work in the Dneprovsko-Pripyatskaya province. In all, the IGiRGI has discovered 324 local anomalies in the province using aerospace studies. Recommended for testing as first-priorities were 128 anomalies. Fifty-four were tested and 44 confirmed. As a result of exploratory survey work on verified photoanomalies, seven deposits were identified and oil and gas supplies obtained at five sites. Thirteen sites were included in the drilling plan. Thus, the prospects for oil production development regions were expanded and the most effective directions were outlined for subsequent geologic survey work.

Positive results were also obtained in other oil and gas bearing provinces and fields with the use of remote oil exploration methods.

In the Bashkirskiy oil bearing region on the slope of the Yuzhno-Tatarskiy anticline and the Blagoveshchenskaya basin zones with increased distribution of tectonic jointing were detected by aerogeologic work of the BashNIPIneft' Institute and serve as indicators of disjunctive interruptions bounding Devonian Graben-like troughs and horst-like uplifts. As a result the possibiliy of a horizon structural interpretation was noted. In all, 30 new anomalies were discovered relative to local uplifts. As a result of the conducted studies, recommendations to organize seismic survey and drilling work were made.

In Prikam'e, according to the results of regional studies by the aerogeologic expedition of the Permneft' association, neotectonic and tectonic zoning in a 55,000 km^2 area was detailed and extended (up to 150 km) linear-oriented photoanomaly zones relative to jointed zones of the substructure were identified. Thirty-six local photoanomalies were discovered by detailed work in Solikamskaya basin near known oil formations along with 48 anomalies in the southern part of Verkhne-Pechorskaya basin and 28 anomalies in the fault zone of the Verkhne-Pechorskaya and Solikamskaya basins. A series of core holes was drilled in two anomalies. It was established that one anomaly corresponds to an uplift in Lower Permian sediment and the second to a structural bench.

Regional aerospace studies carried out by the Tyumenneftgeofizika trust established the presence of a series of linear-oriented photoanomalies relative to the fold and fault zones in the Western Siberian oil and gas bearing province. The large-sized blocks distinguished by a different direction and different amplitudes of movement in the neotectonic stage of geologic development were divided by these hypothetical zones. A natural relationship was observed between the disposition of the hydrocarbon deposits and the characteristics of the neotectonic movements on the basis of comparison of diagrams of the neotectonic zoning with available information on the oil and gas bearing capacity in the studied territories. Interpretation of the data of a specialized photographic survey in the Surgutskiy and Nizhnevartovskiy sections showed that the majority of the known oil and gas bearing formations were reflected in aerogeologic plotting results. In addition, 12 anomalies hypothetically relative to local structures were shown. Two of these anomalies were recommended for detailed seismic survey. The results of remote studies obtained in Srednyy Priob' disclosed new prospects for oil and gas bearing capacity in this region.

A "Space Phototectonic Map of the Aralo-Kaspiyskiy Region" was composed in collaboration with the Aerogeologic Association on the basis of which neotectonic, tectonic and oil geologic zoning of this territory was done and new directions planned for further exploratory work in the Prikaspiyskaya basin, Predkavkaz' and the Mangyshlaksko-Buzachinskiy region.[4]

Forty-four photoanomalies in the northern part of the Dono-Medveditskiy megaarch, seventy in the northern part of the Privolzhskaya monocline and fifty-three in the western part of the Prikaspiyskaya basin were identified by aerogeologic studies made by the VolgogradNIPIneft' Institute. Of these anomalies, 84 were located for the first time and 38 were recommended for geologic survey work. The theoretical possibility of detecting Upper Frasnian shelfs by remoted methods was demonstrated which considerably expands the prospects of discovering formations in traps of this type. It was also ascertained that systems of disjunctive interruptions detected by remote methods produce a characteristic effect on the arrangement of local structures, rift formations and high-capacity traps both of the fissure and the interstitial types. A hole positioned taking into account aerogeologic data gave a commercial flow of oil from the Starooskol'skiy stratum of the Zhivetskiy stage at a depth of 4686 m and thus opened up a new formation.

Tectonic zoning in the Ferganskaya basin was studied in detail by aerospace studies of the SredasNIPIneft' Institute. The location of longitudinal disjunctive interruption zones was specified and the structural system of the transverse fractures was consistently determined along with the transverse neotectonic zoning caused by them. The natural relationships of the spatial arrangement of hydrocarbon deposits and the activity of the structural forms in the Neogenic anthropogenic stage of geologic development were shown.

The structure of zones of deep-level and regional fracturing was detailed in the Naukatskiy trough in the Bol'shaya Kyrkkol'skaya anticline and a number of new disjunctive interruptions detected. All of the fractures were divided into three age generations. According to the results of these studies in the Bol'shaya anticline it was recommended that deep drilling be done.

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4. See: "Space Phototectonic Map of the Aralo-Kaspiyskiy Region, Moscow, 1978.

In the Mangyshlakskaya oil and gas bearing field earlier known fracture zones were traced by regional studies of the Mangyshlakneft' Association and new fracture zones were detected. A system of sublatitudinal and submeridional fractures was detected which was responsible for the block structure of the territory. A structural tectonic diagram of the Rakyshechnoye formation was composed as a result of detailed work.

Remote methods gave positive results in the Timano-Pechorskaya oil and gas bearing province. The Kolvinskoye uplift indicated earlier by geologic survey was detailed by aerogeologic methods. It was included in the list of structures prepared for exploratory drilling.

Correlation of available data makes it possible to conclude that aerospace research is proving to be of assistance in solving an entire series of oil exploration problems.

A regional survey study of oil and gas bearing basins is helping in the listing and reinterpreting of geologic and geophysical data on a uniform basis for an entire basin, in clarifying questions of neotectonic and tectonic zoning, in detailing known and detecting new regional disjunctive interruptions, in composing regional survey maps of tectonic zoning and predictions of the oil and gas bearing capacity for a scientific foundation for subsequent geologic survey work and also in more precise specification of known and discovery of new directions for oil exploration for its future planning.

In regional geologic-geophysical study of oil and gas accumulation zones, aerospace research promotes more precise description of known concepts and discoveries of new characteristics of modern structures, of tectonic and neotectonic zoning of oil and gas accumulation zones, the identification of geologic development characteristics at the neotectonic stage and comparative analysis of newer structural form activity, the identification and detailing of elements of fracture tectonics and the mapping of photoanomalies relative to zones of uplift and large local structures and the predicted estimate of the studied territory and selection of directions, areas and volumes for top-priority oil exploration.

In detailed oil exploration work, remote zoning will promote more precise specification and detailing of the structures of known exploration targets with the development of recommendations for conducting further exploratory survey work, detection of photoanomalies relative to prospective exploratory drilling, evaluation of exploration targets according to their activity in the neotectonic stage and selection of priority targets for subsequent oil exploration, detailing of known and identification of new fracture zones, local disjunctive interruptions, tectonic fault zones and active analysis of the results of geophysical and drilling work with consequent yield of recommendation on the positioning of parametric and exploratory holes.

Preliminary results of experimental studies make it possible to consider promising the use of aerospace methods both at the survey stage and in a number of cases during oil deposit recovery. General acceptance has been accorded to their use for topogeodesic and geologic engineering provision for exploratory survey work, layout of oil fields, construction and operation of oil and gas pipelines and industrial and civil construction.

As regards methods for determining the economic impact of aerospace studies conducted in oil exploration, one has not yet been formulated. It is known that the average cost of regional aerospace studies made by organizations of the Ministry of the Oil Industry on an area 1 km^2 amounts to 17 rubles and 6000 rubles for one photoanomaly zone. The cost of detailed aerospace work on a 1 km^2 area was 58 rubles and 2700 rubles for one photoanomaly.

The aerospace department of Minnefteprom which is in charge of IGiRGI in its scientific research and experimental section has been organized and functions successfully on the whole. The results of the scientific research and experimental work have made it possible to recommend for use a series of procedural and technological developments whose testing under experimental and production conditions has demonstrated their result production and efficiency.

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CSO: 1822

FUELS AND RELATED EQUIPMENT

UDC 55:553.98(571.1)

CONCEPTIONS OF FOLDED BASEMENT ROCK OF WEST SIBERIAN PLATE

Moscow GEOLOGIYA NEFTI I GAZA in Russian No 7, Jul 79 pp 6-11

[Article by S. P. Maksimov and G. Kh. Dikenshteyn (VNIGNI [All-Union Petroleum Geological Exploration Institute])]

[Text] The problem of the oil and gas content of Paleozoic deposits in West Siberia has already been discussed in articles and books. The works of A. A. Trofimuk and his coworkers have a particularly optimistic view of the possibilities of finding hydrocarbon accumulations.

To evaluate the oil and gas content of the Paleozoic complex of West Siberia, particular importance attaches to precise determination of the age of the folded basement rock in this territory. Most investigators consider the West Siberian Platform to be a young one with a Hercynian folded basement. This idea has been reflected in all tectonic maps (Tectonic Map of Eurasia, 1966, edited by A. L. Yanshin; Tectonic Map of the Oil and Gas Regions of the USSR, 1969, edited by L. N. Kozanov; Tectonic Map of the Basement of the West Siberian Plate and Its Surroundings, 1975, edited by V. S. Surkov; Tectonic Map of the Noth Polar Region of the Earth, 1975, edited by B. Kh. Yegiazarov).

Conceptions of the folded basement rock of the West Siberian Plate have been published in many works of N. S. Shatskiy, A. L. Yanshin, A. A. Trofimuk, E. E. Fotiadi, V. S. Surkov, F. G. Gurari, I. I. Nesterov, V. D. Nalivkin, O. G. Zhero, P. K. Kulikov and others.

The most detailed information on this problem is presented in the book "Oil and Gas Geology of West Siberia" [Geologiya nefti i gaza Zapadnoy Sibiri] [3] and is reflected in the tectonic map of the basement rock of the West Siberian Plate and its surroundings which is appended to it.

The authors of the book and map consider that the Baikalian folding is the oldest, and that the Baikalian folds extend in a broad belt along the eastern boundary of the plate and include the Eastern Sayany and the Yenisey Ridge on the south and the Igarsko-Turukhanskiy zone on the north [3]. This band, which the authors call the "Yenisey Folded Zone" of the Baikalian folds, is traced by them as far as the Taymyr system. They are inclined to the belief that the basement of the Ust'-Yenisey and Khatanga downwarps is Baikalian. Ancient plutons are noted on the northeast and southeast of the Baikalian zone to the west of the Yenisey River. In the basement of the plate they distinguish the extensive Uvat-Khanty-Mansi Central Pluton of Baikalian age.

In the southeastern part of the plate, V. S. Surkov assumes, by analogy with the Altai-Sayan Folded Region, the development of a Salairian (early Caledonian) orogeny, and on the southern part near Central Kazakhstan he assumes Caledonian and early Hercynian orogenies. In the central part of West Siberia, a large area extending meridionally to the shores of the Kara Sea is distinguished and is designated as an area of extensive Hercynian folding on the tectonic map of the basement.

Most of the wells data from which were the basis for distinguishing the central Hercynian folding are located in the Middle Ob' region or further south. Well data from further north either is lacking or provides only isolated information.

The Hercynian date for the folding of the central zone of the West Siberian Plate is not unquestioned throughout its extent. I. I. Nesterov [3] accepts the occurrence of Baikalian (rather than Hercynian) folding north of the Middle Ob', and Caledonian and early (rather than late) Hercynian to the south.

The eastern boundary of the Uralian folding runs along a deep fault parallel to the Urals in the western part of the plate. This fault is of immense extent and in the Karatau Mountains it separates the Hercynian and Caledonian folding of the Syrdar'ya and Chu-Sarysuy syneclises, as well as the Hercynian folding of the Urals from the Caledonian folding of Central Kazakhstan in the Turgay depression and the Hercynian folding of the Urals from the Baikalian of the Uvat-Khanty-Mansi Central Pluton further north.

To substantiate the assignment of the basement of the East Siberian plate to a given period of folding, we must have sufficiently reliable factual material on the age of its component rocks.

V. S. Surkov notes that determining the age of the rocks in the West Siberian basement is a complex problem and that most wells reveal metamorphic or igneour rock containing no paleontological remains, so that the dating of these deposits is possible only by absolute methods. Only in rare cases can the age of the rock (limestones and siltstones) be established from fauna. The presumed age of the basement is determined by comparison with the age of surrounding complexes with attention to the regional tectonic situation in which various types of rocks have been discovered [3].

Thus the data currently available do not allow us to solve with sufficient assurance the question of the age of the folded basement of the West Siberian

Plate. The belief that the basement is heterogeneous, of complex structure, that ancient plutons are present and that Hercynian systems extent through the western part of the plate parallel to the Urals, just as the Baikalian folding does in the eastern part of the plate, the Salairian at the prolongation of the Altai-Sayan Folded Region to the southeast and the Caledonian on the south is well-founded. However, it is still unclear how far these folding zones extend into the West Siberian plate.

The identification of a broad and extensive area of later Hercynian folding in the central part of the West Siberian Plate and particularly north of the Middle Ob' is open to doubt. More logical is the assumption that this zone belongs to the Baikalian folding, as indicated by Nesterov.

The Paleozoic complex of West Siberia has been assigned by various investigators either to the folded basement or to an intermediate structual stage.

V. S. Surkov and O. G. Zhero [10] distinguish two structural stages in their discussion of the oil and gas prospects of the Paleozoic of West Siberia with reference to the pre-Jurassic basement. In the lower they include metamorphosed and in some cases even crystalline rock formed by geosynclinal movements of the crust, and in the upper little dislocated, practically unmetamorphosed predominantly sedimentary deposits. They call this stage "postgeosynclinal." In terms of the ages of typical geosynclinal formations, it is assigned to various periods of the Paleozoic. The thickness of this complex is up to several kilometers.

According to the ideas of the abovementioned authors, the postgeosynclinal deposits of the Paleozoic are not continuously distributed and occur only in negative topographic forms. The basis for this conclusion is geophysical data, including gravitational and magnetometric data--which as A. A. Trofimuk correctly points out are not fully reliable.

In the zone where Baikalian folding appears in the Yenisey Ridge and the Eastern Sayany, Archean and Proterozoic blocks have been found. In the northeastern part of the West Siberian Plate, Baikalian folding has been identified in the Igarsko-Turukhanskiy zone [10].

At present there are no factual data on the age of the folded basement of the northern part of the West Siberian Plate. V. S. Surkov stresses the conflicting nature of views on this problem and notes that an area containing late Hercynian folding is shown on the tectonic map of the basement of the West Siberian Plate west of the Igarsko-Turukhanskiy zone. In the opinion of N. N. Rostovtsev, I. I. Nesterov and other investigators, it is not impossible that a folded basement from the Baikalian stabilization exists here [3].

Analysis of available material and data presented in the works of many investigators working on the problem of the age of the West Siberian basement and its oil and gas prospects makes it possible to enunciate certain points regarding this question.

It is helpful to analyze the areal distribution of the Baikalian folding occurring in the Timano-Pechora province and its connection with the Yenisey Baikalian system located in the eastern part of the West Siberian Plate.

It is important to notice--as is indicated in the explanatory note to the tectonic map of Eurasia [12]--that a comparison of the Riphean cross sections of the Yenisey Ridge and Timano-Pechora province shows considerable lithological coincidence.

The presence of individual zones from the Baikalian consolidation in West Siberia is shown on the tectonic map of the West Siberian basement and its surroundings. We may assume that the zone of Baikalian folding took in the whole area north of the Middle Ob' [3]. It is possible that Baikalian folding is more extensively distributed in the West Siberian Plate than is shown by many investigators.

The Uralian system has also undergone Baikalian folding. Finally an immense aulakogene with a breadth of 600 km filled with Paloezoic geosynclinal formations was formed here, after which active tectonic movements occurred, leading to the formation of huge meganticlinorial and megasynclinorial zones of Hercynian folding, separating the Baikalian foldings of the Timano-Pechora and West Siberian provinces.

The pre-Jurassic (Hercynian) basement occurs in the East Urals megasynclinorial and Transuralian meganticlinorial zones, which are partially or wholly covered over by the Mesozoic-Cenozoic cover of the western sections of the plate. Caledonian foldings (or perhaps early Hercynian) occur in the southern part of West Siberia buried under a Mesozoic cover. Their distribution and connection with the Baikalian folds of the West Siberian Plate have not yet been reliably determined.

Thus we should review the conception of West Siberia as a young platform and treat it instead as as ancient epibaikalian platform taking in the territory from the Timan to the Yenisey zone, interrupted by the Urals Hercynian folded region and bounding the pre-Riphean East European and Siberian platforms along a system of deep faults, as well as being bounded by Caledonian (possibly early Hercynian) and Salairian folding on the south. With such a treatment the unique triangular form of the Timano-Pechora province becomes more comprehensible: it should be considered the northwestern part of an immense Baikalian folding zone (Fig. 1).

The conception of a pre-Jurassic basement in West Siberia should be retained only for the western, Uralian zone of the plate. For most of the territory it is more correct to replace it with a pre-Paleozoic basement, and on the south with a pre-Upper Paleozoic, intact, basement. The junction of Caledonian and Salairian folding occurs in this region. On the geological sketch map of the surface of the basement, sporadic volcanic and intrusive acidic and neutral rocks are shown [3]. The oil fields that have been discovered are located in the central part of this region. A geological profile up to 80 km long has been drawn up on the basis of drilling data and the seismic work of H. P. Zapivalov (Fig. 2). This shows upper Silurian and Devonian carbonates and terrigene rocks resting conformably on a sharply dislocated basement of earlier age.

Such a treatment makes evident the likelihood that the thick platform Paleozoic deposits occuring in the Timano-Pechora province occur extensively in the epibaikalian West Siberian platform and on the south of the plate in the zone of younger folding.

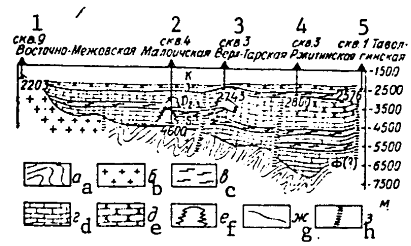

Fig. 2. Pre-Jurassic Formations of the Mezhovskiy Region (after N. P. Zapivalov).

Key: 1. Well 9: Vostochno-Mezhovskaya
2. Well 4: Maloichskaya
3. Well 3: Verkh.-Tarskaya
4. Well 3: Rakitinskaya
5. Well 1: Tavolginskaya
a. Folded basement b. Granites
c. Effusive rocks
d. Limestones
e. Sandstones
f. Formations of reef origin
g. Faulting boundaries
h. Tectonic disruptions

In the Timano-Pechora province, oil-gas content has been established across almost the entire cross section of the sedomentary cover from Silurian to Mesozcic (Triassic) beds, and also in the fissured, weathered crust of the basement. The best-explored reserves are concentrated in the Devonian, the next best known in the Carboniferous-Lower Permian productive complexes. The lower Paleozoic formations have as yet been little studied, but in recent years commercial pools have been found in Silurian rocks. The total thickness of the Paleozoic rocks reaches 7-8 km.

Paleozoic deposits of similar thickness are assumed in West Siberia [10]. It is interesting to note that in the northern areas the maximum depths of the surface of the geosynclinal complex (i.e. the real basement) are 10-12 km, as in the north of the Timano-Pechora province. The regional oil-gas content of the Paleozoic complex has already been shown. Many pools have been discovered in the Timano-Pechora province, and the first pools have been found in the southeast of the West Siberian province.

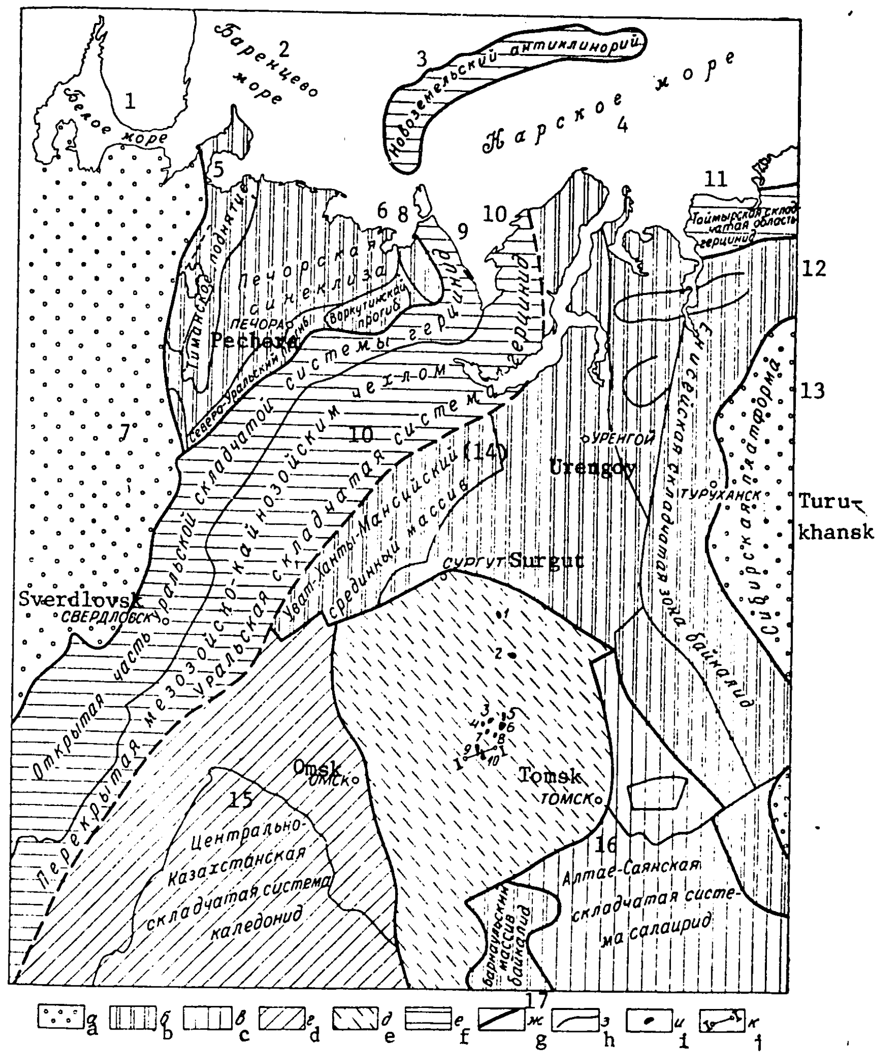

Fig. 1. Age Regions of the Folded Basement of West Siberia and Adjoining Territories (Designations of some structural elements after V. S. Surkov et al.)

A. A. Trofimuk has argued the great oil and gas promise of the West Siberian Paleozoic in many speeches and articles. The question has been given considerable attention in the work of V. S. Bochkarev, V. S. Vyshemirskiy, O. G. Zhero, N. P. Zapivalov, A. E. Kontorovich, P. K. Kulikov, I. I. Nesterov, F. K. Salmanov, V. S. Surkov and others.

The authors of the present article confirm the high estimate of the oil and gas content of West Siberian pre-Jurassic rocks, which they consider to be a thick platform complex covering most of the territory atop a Baikalian folded basement.

The proposal made above regarding the tectonic assignment of the West Siberian Paleozoic complex is based on the general patterns of distribution of Baikalian folding and on a new approach to analyzing factual data from a number of investigators. We must stress its great theoretical and practical importance. An extenive program of regional work should be developed, including the drilling of deep reference and parametric wells and performance of geophysical work, which would provide new data for a more intensive development of geological exploration work aimed at discovery of hydrocarbon deposits in Paleozoic formations in the extensive West Siberian area. Judging by data from V. S. Surkov and O. G. Zhero [10], north of the Middle Ob' wells up to 5 km deep and in some cases up to 7 km deep would completely open up the Paleozoic deposits. In addition to material for a study of the stratigraphic column and its oil and gas content, this would provide more reliable data for interpretation of geophysical studies, which in turn would make it possible to identify favorable areas for wildcat and exploratory drilling work.

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Key to Fig. 1:

Folded regions of various ages:
a: Pre-Riphean
b. Baikalian
c. Salairian
d. Caledonian
e. Pre-Upper Paleozoic intact
f. Late Hercynian

Boundaries:
g. Folded regions of different ages
h. Tectonic elements within these regions
i. Oil pools or oil shows of commercial commercial importance in Paleozoic deposits:

1. Medvedovskoye
2. Ukalovskoye
3. Tambayevskoye
4. Urmanskoye
5. Severo-Ostaninskoye
6. Ostaninskoye
7. Nizhnetabaganskoye
8. Kalinovoye
9. Maloichskoye
10. Verkh-Tarskoye

j. Contour line

Area names [typewritten numerals]
1. White Sea
2. Barents Sea
3. Novaya Zemlya Anticlinorium
4. Kara Sea
5. Timan Uplift
6. Pechora Syneclise
7. North Urals Downwarp
8. Vorkuta Downwarp
9. Open part of Urals Fold System (Hercynian)
10. Covered by Mesozoic-Cenozoic cover: Urals fold system (Hercynian)
11. Taymyr fold system (Hercynian)
12. Yenisey folded zone (Baikalian)
13. Siberian platform
14. Uvat-Khanty-Mansi Central Pluton
15. Central Kazakhstan fold system (Caledonian)
16. Altai-Sayan fold system (Salairia (Salairian)
17. Barnaul Pluton (Baikalian)

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FUELS AND RELATED EQUIPMENT

UDC 553.982:550.812(571.12-17)

SEARCH FOR OIL ACCUMULATIONS IN THE NORTHERN REGIONS OF TYUMENSKAYA OBLAST

Moscow GEOLOGIYA NEFTI I GAZA in Russian No 7, 1979 pp 1-5

[Article by F. K. Salmanov, O. A. Remeyev and F. Z. Khafizov (Glavtyumengeologiya [Tyumen Main Administration for Geology]]

[Text] In the initial stage of geological exploration work in the northern regions of West Siberia, investigation was primarily of upper Cretaceous deposits, where large natural gas pools have been found in the Cenomanian part of the column. It was assumed that large oil accumulations might lie below the gas deposits in the Neocomian and Jurassic complexes. But the first gas wells to open up Neocomian rock (for the Jurassic deposits have still gone practically unstudied) in most cases found gas condensate deposits and less frequently oil-gas condensates. This circumstance provided some investigators with grounds for denying that the northern regions were promising for oil. Others considered these data as a reason to plan more thorough investigations aimed at separate forecasting of the oil and gas prospects of individual territories and parts of the stratigraphic column and at making a successful search for oil accumulations.

Currently various approaches are being taken to these questions. This article considers some aspects of the problem.

In filling traps, natural gas has by virtue of its physical properties certain "advantages" over oil. A natural reservoir containing oil continues to be a trap for gas, since the gas can force the oil out and take its place. A reservoir filled with gas, on the other hand, ceases to be a trap for oil, since the oil has a much higher density and cannot force the gas out. These processes form the basis of the principle of differential trapping of hydrocarbons, which is extensively used in oil geology to explain the distribution of oil and gas deposits [4]. Many examples of the forcing of oil from a trap by gas can be offered. For example, in the gas cap of a deposit in formations of the AV group in the Samotlor field, according to core data and radioactive studies the residual oil saturation is 30-35 percent. The oil saturation is higher the worse the reservoir rock, which is an additional proof of the forcing out of oil by gas rather than occurrence of any other process during formation of the oil-gas deposit. The same characteristics have been identified in the oil-gas deposits of the Fedorovskoye, Lyantorskoye, Var'yeganskoye and a number of other fields.

Thus we can state that an abundance of natural gas in a given productive complex has a negative effect on the formation and persistence of oil deposits.

In gas condensate deposits of the Neocomian in the northern regions of Tyumenskaya Oblast, a significant quantity of residual oil has also been identified, which attests to the above-mentioned "advantages " of natural gas in filling traps. However, there is no basis for asserting that there has been so much gas here that the possibility of formation and persistence of oil accumulations is completely ruled out. Many investigators [3] consider that a large quantity of gas (assuming separation of gas from formation waters during a drop in pressure) is accumulated primarily in young high-amplitude reservoirs, while oil deposits have been able to accumulate and persist in traps located in regional depressions or saddles. In this connection it must be stressed that test drilling has been carried out in precisely the highest-amplitude young uplifts. But even under these conditions many gas condensate accumulations in Neocomian rocks are accompanied by significant oil margins and "cushions," indicating that the quantity of gas has not been absolutely excessive.

Nonetheless, we cannot rely solely on the supposition that depression-type territories have oil promise without taking account of other directions in the search.

Starting from the principle discussed above, that gas has a negative effect on the formation and persistence of oil accumulations, we have formulated the reverse problem: does not nature include traps which can hold only oil? The correctness of this way of posing the question stems from the greater mobility of gas than oil in a reservoir: gas is able to pass through poorly permeable rock through which liquids cannot percolate. Clearly, the difference in density between oil and gas on the one hand and formation water on the other is also of major importance, since it creates anomalous pressures in the uplifted parts of deposits. For example, the excess pressure in an oil deposit 100 meters high is roughly 0.3 MPa. For a gas deposit, at the same height it will be 0.97 MPa, i.e. more than 3 times as great.

Since traps capable of holding oil and not able to hold gas are possible in nature, we turned our attention to lithological, stratigraphic, structural-lithological and structural-stratigraphic traps, including those connected with lithological replacement or stratigraphic pinching out of reservoirs along the strike.

As is well known, structural (or arch-stratum) traps have a positive closed structure (uplifting) with a continuous distribution of the reservoir. The cutoff of such a reservoir, i.e. the hypsometric level at which it has its maximum capacity of oil or gas, coincides with the elevation of the lowest closed structural contour of the reservoir cover. Fig. a takes this elevation arbitrarily as 1,900 meters. In principle the traps are still structural in the cases when the distribution of the zone in which the location of the zone in which the stratum is replaced has no effect on the level of the cutoff of the trap, which results from structural factors (see Fig. b). In structural-lithological traps it does have such an effect, and the cutoff of the trap is hypsometrically lower than the lowest closed structural contour in the reservoir cover (Fig. c). In this case the trap consists of two parts: one resulting from the presence of a closed positive structure (down to the lowest closed structural contour, which in our example is in the range of -1860 to -1900 meters, where the trap would exist even if there were no lithological replacement of the stratum), and a second, characterized by the lithological factor, i.e. by crosscutting of the hypsometrically lowest structural contour by a zone of stratum replacement (in our example this area is located between the -1900 and -1930 meter levels, which would not have been part of the trap had there been no replacement of reservoir rock.

Lithological traps are formed by cross-cutting of some non-closed structural combination by a zone of reservoir replacement, e.g. a structural projection or the like (if it were not for lithological replacement of the stratum, such a trap would not exist at all: see Fig. d). The essence of the structural-stratigraphic and stratigraphic traps is similar.

The replacement of reservoir rock by "solid" rocks is accompanied overall by a gradual decrease in the percolation capabilities of the stratum. At the same time, as was stated above, the mobilities of oil and gas differ sharply. In particular, it is well known that the lower limits of rock permeability to oil and gas differ: by at least one order of magnitude and possibly by two. The combination of the two abovementioned circumstances should inevitably mean that at some critical permeability the bed will cease to be a reservoir for oil but will still be able to let gas through for some distance.

Evidently at a certain distance from the zone which prevents the movement of oil, the bed will become impermeable to gas as well (when the replacement has a regional character), and in this strip, structural-lithological and lithological gas traps are likely to be formed. But the capacities and percolation properties of the rock in such a zone will already be so low that it will be practically impossible for wells to produce a commercial flow of gas and to pin down the locations of deposits. It is clear that about the same results will be obtained in stratigraphic pinching out of reservoirs, when percolation of gas along the plane of the stratigraphic unconformity will be possible even beyond the line of pinching out of the reservoir, where a barrier to oil is formed.

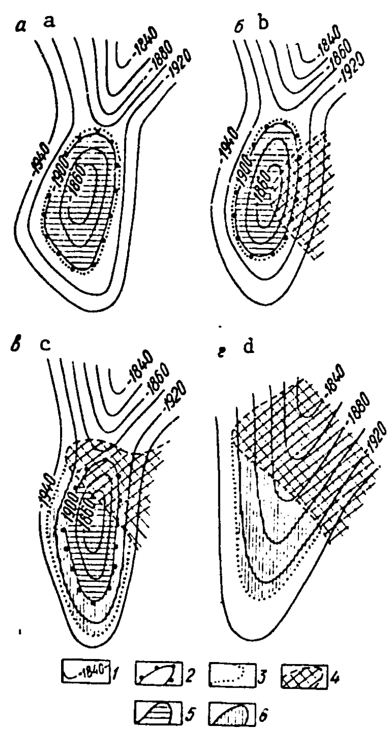

Diagram of trap structure: structural (a), structural complicated by a zone of argillization (absence) of reservoir rock (b), structural-lithological (c), lithological (d). Contours in meters.

Key: 1. Reservoir cover
2. Lowest closed contour in cover
3. Elevation of trap cutoff
4. Zone of replacement (absence) of collector

Traps (parts of traps) resulting from:
5. Structural factor
6. Lithological (stratigrapnic) factor

In addition to structural traps, several dozen structural-lithological and structural-stratigraphic traps, along with a considerable number of purely lithological or stratigraphic ones, have been discovered in West Siberia. In all of these cases, the traps have proven to be saturated with oil and there has not been a single one that has not produced a commercial flow of gas beyond the boundaries of the closed positive structures. It is quite clear that this is no accident.

For example, in the Shaimskiy oil-bearing region and the Berezovskiy gas-bearing region, the distributions of the Jurassic productive stratum are practically identical. It extends along the slopes of uplifts of the basement and occurs in trough-shaped downwarps. The stratum is pinched out toward the summits of the uplifts of the basement and toward the crests of periclinal downwarps and structural projections. The zones in which it is absent can frequently be traced beyond the positive structures, as a result of which structural-stratigraphic and stratigraphic oil traps are formed (Shaimskiy oil-bearing region). In similar situations, gas deposits (Berezovskiy region) are located only inside the closed structural contours of the positive structures in the reservoir cover, and never extend beyond them. Accordingly, stratigraphic pinching out of the reservoir in this case does not form barriers to gas, as a result of which it passes along the plane of stratigraphic unconformity.

In the Central Ob' oil-gas region too, only oil deposits have thus far been found in lithological and structural-lithological traps (Mamontovskoye, Yuzhno-Surgutskoye, Povkhovskoye, Pokamasovskoye and other fields). The gas caps of oil-gas deposits do not go beyond the bounds of the structural parts of the traps (Vyngapur field).

It should be noted that in other oil and gas provinces too oil deposits are primarily located in nonstructural traps.

In the Western Ciscaucasian Monocline, for example, more than 10 oil deposits and not one gas deposit have been found in traps located in a zone of pinching out of the Maykop reservoirs [1, 2]. Many nonstructural oil deposits have been found in the upper structural stage of the Azov anticlinal zone [1], while the only gas deposit (the Severo-Akhtyrskoye field) is located in an anticlinal trap; in the lower structural stage, where tectonic complications of anticlinal folds are the reservoirs, oil, gas-oil and gas deposits are found (Zybza-Glubokiy Yar).

Apparently in insufficiently compacted sandy-shaly rocks of the Mesozoic of West Siberia, this predominant oil-bearing characteristic of nonstructural traps is particularly typical. Here we are fully justified in expecting that even when there is an excessive quantity of gas, which has a negative effect on the formation and persistence of oil deposits, it will be primarily oil accumulations that will be found in litholgical and stratigraphic traps and also in the parts of structural-lithological and structural-stratigraphic traps which are produced by these factors.

In the northern regions of West Siberia and also in the Middle Ob' area, it is probable that lithological and structural-lithological traps occur extensively. In particular, the example of argillization of Neocomian deposits toward the west until sandstone deposits completely disappear in Mansi Syneclise (a zone in which the so-called Frolovian series, consisting primarily of argillites and shales, is extensive) is well known. In recent years, investigations [5] using the properties of sedimentation conditions have made possible a detailed and more reliable correlation of the sections of the Neocomian and a significant refinement of the patterns of replacement of sandstone beds by shaly rocks.

It has been established that the sandstone beds of the Neocomian in both the central and northern regions of West Siberia are replaced in a west-northwesterly direction from the bottom up in a gradual manner. The lines of replacement run from south-southwest to north-northeast, cutting through this entire extensive territory. When in favorable combination with the structural layout, i.e. on the east-southeast slopes of local uplifts, and also on complications of the structural projection type which are descending in this direction and the like, they can form structural-lithological and lithological traps which are promising for oil prospecting.

The total quantity of sandstone strata in the Neocomian cross section is considerable, and accordingly the zone of replacement of each successive stratum from below occurs at about 20-25 km intervals proceeding toward the north-northwest. This means that the conditions for formation of a large number of lithological and strucural-lithological traps and associated oil deposits are in existence here.

Many such deposits have been found in the Middle Ob' region (Mamontovskoye, Yuzhno-Surgutskoye, Povkhovskoye, Vyngapurskoye and a number of others). The very first systematic search for such deposits in the northern areas also gave positive results. Deposits have been identified in structural-lithological traps in the Tarasovskaya, Vostochno-Taroksalinskaya, Pestsovaya and a number of other tracts. Available data on the structure of the region and on the directions of the lines of replacement of strata make it possible even now to mark out another series of areas for oil-prospecting wells. In particular, the most promising are areas in the southeastern periclinal descent of the Komsomol'skiy, the eastern slope of the Yamburgskiy, the Yen'-Yakhinskiy, Vostochno-Urengoyskiy and a number of other uplifts.

The main aspects of a procedure for seeking such deposits are also being worked out. In wildcat drilling on new structures, the first well is sunk on the arch of the uplift and the second, independently, on the east-southeastern descent so as to find structural-lithological deposits. When seeking lithological deposits, it is clearly still preferable to site the second well in the light of results from the first, locating it across the line of stratum replacement, i.e. to the west-northwest or east-southeast of the first well depending on the location of the latter: whether in the water-containing zone of the stratum or in the argillization zone. In any case, wildcat wells must fully open up the part of the Neocomian strata containing the shelf sandstone beds, since in each individual sector the conditions for formation of lighological or structural-lithological traps will occur in the lowest of these beds (in this case ignoring deep-water lenticular beds of the so-called "Achimovian group" lying at the bottom of the Neocomian.

Thus we may assert that in the stratigraphic column of the West Siberian Mesozoic the majority of lithological and stratigraphic traps and those strucutral-lithological and structural-stratigraphic traps produced by these factors contain oil and do not contain free gas. Since such traps occur extensively in this region, this pattern enables us to assume the existence of certain quantities of oil in them. Taking account of these circumstances will be of great assistence in the systematic search for oil accumulations, particularly in the northern regions of West Siberia.

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